CIRCULAR MOTION

1. A stone on a string is whirled in a vertical circle of radius 80 cm at a constant angular speed of 16 radians per second.

   Calculate the speed of the stone along its circular path.

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Speed = ...

(2)

Calculate its centripetal acceleration when the string is horizontal.

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Acceleration = ...

(2)

Calculate the resultant acceleration of the stone at the same point.

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Resultant acceleration = ...

(3)

Explain why the string is most likely to break when the stone is nearest the ground.

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(2)
(Total 9 marks)

2. State the period of the Earth about the Sun.

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Use this value to calculate the angular speed of the earth about the Sun in rad s^{-1}.

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Angular speed = ...

(2)

The mass of the Earth is 5.98×10^{24} kg and its average distance from the Sun is 1.50×10^{11} m. Calculate the centripetal force acting on the Earth.

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(2)

What provides this centripetal force?

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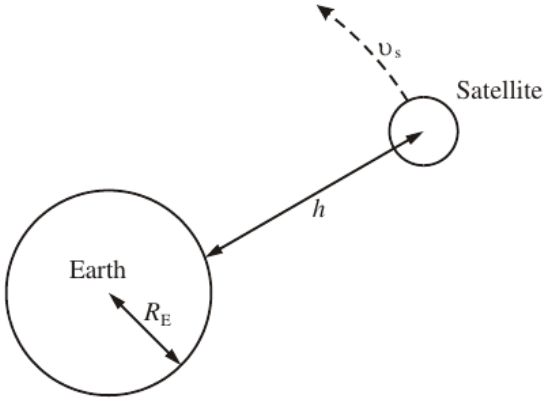
(1)
(Total 5 marks)

3. The diagram (not to scale) shows a satellite of mass m_s in circular orbit at speed □$_s$ around the Earth, mass M_E. The satellite is at a height h above the Earth's surface and the radius of the Earth is R_E.



Using the symbols above write down an expression for the centripetal force needed to maintain the satellite in this orbit.

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(2)

Write down an expression for the gravitational field strength in the region of the satellite.

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State an appropriate unit for this quantity.

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(3)

Use your two expressions to show that the greater the height of the satellite above the Earth, the smaller will be its orbital speed.

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Explain why, if a satellite slows down in its orbit, it nevertheless gradually spirals in towards the Earth's surface.

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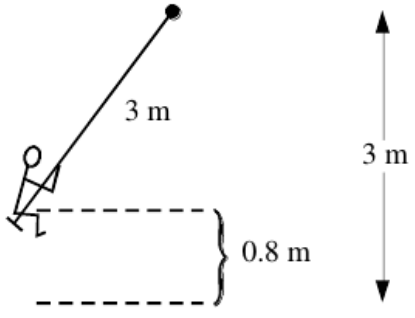
(Total 10 mar

4. A child of mass 21 kg sits on a swing of length 3.0 m and swings through a vertical height of 0.80 m.



Calculate the speed of the child at a moment when the child is moving through the lowest position.

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(2)

Calculate the force exerted on the child by the seat of the swing at a moment when the child is moving through the lowest position.

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Force = ...

(3)

Explain why, as the amplitude of the motion increases, children may lose touch with the seat of the swing.

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(2)
(Total 7 marks)

5. A satellite S orbits the Earth once every 87 minutes.

Show that its angular speed is approximately 1×10^{-3} radians per second.

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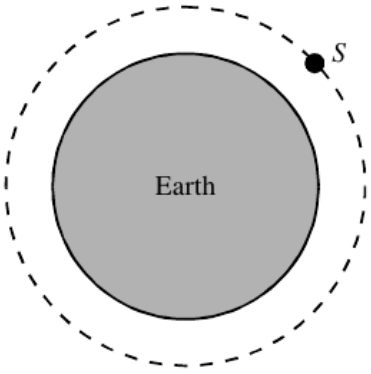
(2)

In the space on the right draw a free-body force diagram for the satellite in the position shown.



(1)

With reference to your free-body force diagram, explain why the satellite is accelerating.

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(1)

The radius of the satellite's orbit is 6500 km. Calculate the magnitude of its acceleration.

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Acceleration = ...

(2)
(Total 6 marks)